RINECO

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF ARKANSAS
WESTERN DIVISION

UNITED STATES OF AMERICA.	)	
	)	
Plaintiff,	)	
	)	
v.	)	Civil Action No. 4-07-CV-01189SWW
	)	
RINECO CHEMICAL INDUSTRIES, INC.	)	
	)	
Defendant	)	

EXPERT REPORT OF

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Summary

I, Donald L Corwin, PE have reviewed documents supplied by Rineco to evaluate the operation of the Thermal Metal Wash (TMW) and Indirect Thermal Desorption (ITD) hazardous waste processing unit. My major opinions are listed below in bullet format with a more detailed discussion below. I have many other opinions on the operation that while significant to an operating engineer do not add substance to this report. The opinions provided below are made to a reasonable degree of engineering certainty. This is based on my engineering experience designing, operating and troubleshooting incinerators, oxidizers, and Boiler and Industrial Furnaces (BIF) units as well as my review of the documents provided by Rineco and the depositions taken to date in this case. A listing of the documents reviewed by Bates number range is supplied in Appendix 1. My CV is included in Appendix 2.

- Oxygen is drawn into the TMW and the ITD units during normal operation when a negative or almost negative pressure in maintained in the unit.
- The oxygen drawn into the system and halogens supplied as part of the hazardous waste partially oxidized material in the TMW. This operational also took place in the ITD.
- TMW and the ITD use thermal treatment to generate organic and inorganic hazardous waste streams which result from the partial combustion (i.e. oxidization reduction), and pyrolysis (decomposition) of the hazardous waste feed to the unit.
- The vast majority of the output of hazardous waste from the TMW is collected and sent to BIFs (such as cement kilns) or other hazardous waste facilities as a fuel or is of disposed in RCRA incinerators.
- The annual metal percentages of TMW feed has varied from 20% up to 32% from 2003 to the present. Much of the metal processed through the TMW was metal that could have been processed, more cheaply in the Rineco Barrel Decontamination Unit (BDU).
- Fugitive air emissions occur when a negative pressure is not maintained in the TMW during an upset condition. There are frequently recorded observations of upset conditions in the TMW and the ITD.
- The fugitive emissions are composed of a wide variety of gases generated by the vaporization and decomposition of the organic and inorganic hazardous wastes processed in the TMW

- The vaporization and decomposition gases are a product of the partial combustion and pyrolysis of the hazardous waste. This is an integral part of the thermal treatment process.
- The thermal oxidizer unit (TOU-102) is a ground flare that continues the oxidization of the hazardous gases and particulate matter generated in the TMW without any air pollution control (APC) system resulting in uncontrolled air emissions of hazardous gases and particulates that have not been quantified.
- The TOU-102 is an integral part of the TMW by acting as an afterburner to continue the process of destroying the hazardous gases generated in the TMW.
- Rineco's profit analysis lists income of 0.6% of the operational budget from metal. Based on the documentation provided thus far, better than 99% of the TMW income is derived from the receipt of hazardous waste.

System Description

The Rineco facility located in Haskell, Arkansas operates a hazardous waste processing unit identified as the TMW. The current TMW replaced a hazardous waste treatment unit designated as the ITD. Both units treat the hazardous waste feed stream to generate different solid and vapor hazardous streams and a metal stream. These hazardous waste streams are disposed of at a cheaper cost to generate the operational revenue. Metal is also extracted as a minor portion of the process.

The TMW is composed of the feed, hot oil thermal screw, electric heating screw, cooling screw section, separation section, venturi scrubbers, fume collection system and the TOU-102. Ancillary equipment includes a bag house, transfer screws, feed chamber with live bottom screws, magnetic metal separator, vibratory section and removable tote bins.

old unit

The ITD was a typical calcine kiln. A calcine kiln is a rotary kiln where heat supplied to the external surfaces. The material to be heated is inside the kiln and exposed to a controlled atmosphere. This configuration allows for tight control of the atmosphere (hazardous waste gases) inside of the kiln. Ancillary equipment detail was limited for the ITD. The operational principal of vaporization and decomposition was the same for the unit, but the mechanism to achieve the vaporization and decomposition, as noted above, is different.

The TMW treats hazardous waste materials that have been processed by the shredders located at the Rineco plant. Additionally some of the listed and non listed hazardous waste materials are fed directly into the TMW if the material characteristics are within the feed limits of the TMW. Some of these items are spray paint cans[1] and other loose items[2, 3] that do not require shredding to pass through the metal separation device.

The TMW is configured to receive a wide variety[4] of hazardous waste materials. These include paint tools, personnel protective equipment, filters and miscellaneous floor clean up[5]. Thus it is apparent that the stated feed is most of the hazardous waste material accepted by the plant. Clean metal, that could be processed by other more cost effective means is added to maintain the desired metal weight percentage[6, 7, 8].

The general concept of the TMW system is best described by the Vu preliminary Piping and Instrumentation Diagram (P&ID) diagrams[9]. These simplified diagrams provide an overview of the TMW equipment installed to process hazardous waste. Later P&IDs[10] are not completed to the industry standard level of detail. There is no complete set of P&IDs of the system found in the documentation supplied showing all of the instrumentation and the instrumentation interconnections.

The operational details of the system were pieced together using the information supplied by Rineco, deposition testimony, photographs of the site, and a site visit on 05 August 2008. Additional information is obtained from the Rineco training manuals, the modified flow diagram[11], the SOPs[12], process description[13], dust system[14, 15], operating discussion[16] and the simplified TMW diagram[17]. These provide additional overview information. Other documentation provided by Rineco was reviewed and utilized as secondary information. These are too numerous to list separately in this report. A summary of the Bates numbered documents is provided in Appendix 1.

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[1] ERIN00036116
[2] Patty Deposition page 60
[3] ERIN00014182
[4] ERIN00031766
[5] ERIN00006012
[6] ERIN00031526
[7] Cummock Deposition pg 34
[8] Tallent Deposition Pg 57
[9] ERIN000033059
[10] BB Equipment Identification Fig 89 and Fig 105 ERIN000033777
[11] R001716
[12] ERIN00016763
[13] ERIN00005316
[14] ERIN00010855
[15] ERIN00011695
[16] ERIN00012291
[17] R001792

Plant Trip

A site visit was made of the Rineco facility on 05 August 2008 to review the plant operation. Mr. Williams served as tour guide. A summary listing of the observations is provided below.

- The shredders monitor the oxygen concentration below the shredder jaws. The oxygen monitor is loosely placed in the pipe holder. A slightly negative pressure is used to extract the gas from the plenum below the shredder.
- The oxygen concentration in the area below the metal shredder jaws is maintained below 10% oxygen.
- The totes are open topped containers with hazardous shredded and non-shredded material placed into them for placement in the TMW. Lids are placed on the totes. The freeboard area is atmospheric air.
- The totes are opened and the TMW feed hopper is open to the atmosphere when the totes are dumped.
- The oxygen probe is mounted on a small pipe line on the TMW. The hand valves were 80% closed while the unit was in the standard mode of operation. Piping on the other side of the probe is tubing.
- Only one oxidizer probe monitors the TMW gases.
- The oxygen monitor was observed to have a value of 43%. The stated span of the instrument is 0 to 100%.
- Mr. Williams stated that the oxygen span is obtained from atmospheric air.
- Pinhole leaks in the expansion piping at the venturi tubes showed evidence of corrosion and leakage. RTV "red" appears to be the preferential sealing compound for these leaks.
- The aerosol cans collected in the processed metal container were not shredded.
- The electric screw section was operating at a control temperature of 1500 Deg F.
- The hot oil heater was operating at a control temperature of 600 Deg F.
- The surface composition of the observed feed tote was mainly disposable gloves and other plastic items. No effort was made to dig into the tote.
- The TOU-102 is a standard ground flare that is intended to continue the oxidization process.
- There are two feed pipes (3 inch and 6 inch) connecting the TMW to the TOU. Each line has a flame arrester mounted near the TOU. The pipes combine into one feed line. This feed line enters the burner section of the ground flare.
- The TOU-102 ground flare uses natural draft to supply the required combustion air to meet the heat load produced by the vents. During

periods of rapid organic fluctuation, the air will lag the organic oxygen demand.

- There is no additional air pollution control on the TOU-102 unit for particulates, NOx, SOx, halogen acid, and organic material.
- The TOU-102 is the organic pollution control system for the hazardous organics generated in the TMW. This is characteristic of an afterburner on hazardous waste incinerator systems.
- A significant flow of organic material was observed being burned during the observation period. The two air dampers were observed to travel from closed to full open position.
- The control temperature could not be observed on the faceplate of the temperature controller mounted on the TOU-102 control panel.
- The two pipes connecting the TMW to the TOU are insulated with metal covers.
- The 3 inch line has an orifice mounted line near the heat exchanges. No information was provided on the orifice.
- Liquid knockout legs were observed in the 3 inch line to the TOU.
- The outlet of the oxygen sensor line appears to enter the 3 inch line upstream of the orifice.

TMW Operational Description Analysis

The operational characteristics of the Rineco TMW can be deduced from the information supplied, depositions, the plant trip and from my knowledge of similar systems. Review of the unit was hindered by the absence of a complete P&ID. Reliance was made on the partial application of pre-modification P&ID diagrams[18]. It was readily apparent that the piping had been modified and these drawings were not an accurate representation of the current piping and instrumentation. All analysis and conclusions may be adjusted based on additional information obtained from future depositions and receipt of accurate P&ID documentation. As additional information is received to clarify points of assumption, the opinions listed below may be modified.

Feed System

The feed system is made through an enclosed hopper[19] with a live bottom[20] screws. A secondary auger[21] transports the hazardous and non-hazardous waste into the hot oil screw section.

[18] Id Footnote 10
[19] ERIN00016775
[20] ERIN00033059
[21] ERIN00033579

The feed system has the door opening on the feed container. Two sets of twin screws are installed in the bottom[22]. A plug is to be maintained in the vessel to assure that the air is not drawing into or out of the system through open doorway.

Material was observed fed into the system during the site visit. The feed materials were observed to be gloves and other plastic like material in addition to unrecognizable mud like material. Rags[23, 24] are processed by the unit and cause considerable operational problems. The unit has to "rock"[25] to degrade the rags[26] to the level that they can be separated from the metal. As shown by this reference, the rocking was not necessarily performed to clean the metal.

The material fed into the TMW is a mixture of hazardous and non-hazardous waste. Hazardous waste in full barrels, cardboard containers[27] and loose material is placed into the feed hopper.

Oxidization of Material in TMW

The Rineco facility has installed two different hazardous waste processing units to reduce the hazardous and non-hazardous waste to oil, gas, char and non-char materials. The first unit was designated the ITD[28, 29] is an On-Site Technologies soil desorption unit[30, 31]. The ITD was installed in 2003 as part of the Fuel Production process[32] at the Rineco Facility. Numerous operational problems led to the removal of this unit. The ITD was removed from operation in August 2004[33].

A new unit had been in design phase[34, 35] prior to the removal of the On-Site unit. The new equipment[36] consisted of two heated screws[37] to heat the material instead of the single kiln. Other modifications[38] were made to improve the

22 ERIN00033572
23 ERIN00015714
24 ERIN00012178
25 ID Footnote 23
26 ERIN00015715
27 ID Footnote 8 page 58
28 R001549
29 R001804
30 R001563
31 ERIN00015187
32 ERIN00006010
33 R001726
34 ID Footnote 16
35 ID Footnote 2 Page 43
36 ERIN00005321
37 Id Footnote 20
38 ERIN00013722

operation of the process. The basic operational philosophy of combusting and decomposing the feed materials[39] was maintained in the new unit.

Materials fed into both of the Rineco units were designed for and subjected for oxidization reactions as part of the process. Oxidization is defined as a reduction of the feed organic compounds into different chemical compounds. Oxidants can be oxygen, halogens and other elements that combine with the carbon and hydrogen in the feed materials. The combination changes the initial chemical compound into many different chemical compounds.

Pyrolysis is the breaking down of a chemical compound without an oxidant present. Partial pyrolysis of the feed stock is also noted by the formation of hydrogen[40] and carbon/coke[41, 42]. The char is noted to have heating value[43] and is mixed into the fuel (HVL[44] supplied to BIF units. All of these processes change the chemical nature of the material processed by the unit.

Oxygen is present in many sections of the TMW. The mixing of the hazardous waste with the oxygen at the process temperatures is sufficient to promote partial oxidization of the hazardous and non-hazardous waste fed into the TMW. Operational logs note the presence of smoke exiting[45] the unit when the appropriate negative pressure is not maintained in the system. Operational logs[46] even indicate that "flames coming out the side of the E-screw". The visible smoke and flames indicate that there are openings, however small in the system. When the smoke is not exiting the system, ambient air enters at those locations because the system is maintained at a negative pressure.

Oxidization is generally an exothermic process. The chemical compound will release heat when oxidized. The amount of heat is a function of the oxidization process. The Rineco process has many instances of high exit temperature gases[47]. The high recorded temperatures after the gases pass through the venturi scrubbers are the result of very high flow rates and high inlet gas temperatures. The high temperatures are the result of oxidization in the chambers. The high flow rates are the result of very high volatile loading on the system. Thus the

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39 ERIN00016765
40 ERIN00010558
41 ERIN00010524
42 ID Footnote 7 page 19
43 ERIN00037584
44 ID Footnote 2 Page 88
45 Typical R034310, R035025, R035489, R035517, R035547, R035571, R035637, R035869, Erin00015704
46 R035904
47 R034781, R035112, R035120, R035517

two operational conditions are the uncontrolled overloading of the system and oxidization within one of the two heating screws.

Temperatures are not measured within the TMW unit[48]. Therefore, no conclusion can be reached with the available data as to the overloading of the system or exothermic reaction in the system. The process exit temperature on the ITD unit was stated to be on the order of 1000 Deg F[49]. The TMW[50] was estimated to have a material exit temperature of 1100 Deg F. This is based on a heater temperature of 1100 Deg F. The current operation temperature for the electric heaters is 1500 Deg F as was observed during the site visit and documented in the SOP[51].

Output Streams

There are several stated output streams from the TMW. These are designated[52] as Overs, Diverted, HVL Char, Oil tanker, Water, recycled metal, pail and E-D materials. Each of these streams exits the TMW after being exposed to the heated screws. Some of the material is reprocessed because it does not meet the specifications for continued processing of the hazardous waste by other facilities. The char is generated in the TMW as coked material. The feed material is partially degraded in the presence of heat and some oxygen. This material, as stated above, has a heating value. It is sent to a hydropulper/disperser where it is mixed with other hazardous waste to form high viscosity liquid (HVL). This material is disposed of in a BIF unit (cement kiln etc) as a hazardous fuel. The pail material is also handled in a similar manner.

The annual mass balances[53] for both the ITD and the TMW show that the main output from the system is hazardous waste feed which is sent to the kilns or other hazardous waste incinerators. The metal percentage is less than 20%[54] unless non-contaminated metal is added to the stream.

The method that the system is operated allows for large discrepancies to be encountered when defining the input and the output of the unit. The mass balances indicate that the system is poorly instrumented to allow for large discrepancies in the hazardous waste output streams. The annual mass balance reports show a net loss of hazardous waste. This loss is attributed to fugitive vapor emissions escaping TMW and non-condensable vapors vented from the

[48] R000644
[49] ID Footnote 13
[50] ID Footnote 49
[51] ID Footnote 19
[52] ERIN00031479
[53] ERIN00036923
[54] ERIN00031527

TMW to the TOU. Both vapor streams are the result of partial oxidization and pyrolysis of the hazardous waste in the TMW.

Many periods of time show a negative balance. A negative balance indicates that more material came out of the machine than went into it. On a one or two shift basis (12 hour shift) a small variability can be expected. But the "waste generation" in the ITD and the TMW occurs over several days. The published mass balance[55] even has more hazardous waste exiting the system than is fed into the system for a whole month. Thus it is evident that the plant does not have good control over the material quantities in the old ITD and the new TMW. The mass balance is made based on weights at several locations and a water flow measurement. The flow orifice located on the 3 inch line is not documented as to its purpose or the flow rates that it measures.

The economics for the operation are summarized in a monthly profit report[56]. The report details the cost reduction for disposing of the hazardous waste in a lower cost method relative to the cost of the "raw"' hazardous waste as received.

Vapor/Fume Collection

The vapor/fume system [57]consists of several water venturi, two high pressure blowers and the ducting connecting the TMW to the TOU. The blowers provide the motive force to maintain the TMW and the other ancillary equipment under a negative pressure. This will reduce fugitive emissions. It also allows air (oxygen) to be drawn into the unit at any location where there will be emissions when the pressure is not maintained negative.

The venturi sections uses water to condense some of the condensable gases[58]. These gases were vaporized during the heating and decomposition of the hazardous waste materials. They also could be condensable gases generated in the TMW when the waste material is combined with any oxidant in the heated vessels. The liquid traps in the 3 inch line to the TOU indicate that some of the liquid is known to escape the venturi system.

The venturi will cool the gas to a plant controlled temperature. The early stated design temperature to condense a majority of the condensable materials was 90 Deg F[59]. This temperature was raised to a control temperature somewhere in the

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55 ERIN00031436 May
56 ERIN00031691
57 ID Footnote 10 Fig 89 and Fig 105
58 ERIN00016802
59 ERIN00005992

3 inch line of 130 Deg F[60, 61]. At this scrubber exit temperature increased additional gases generated in the TMW are sent to the TOU.

The oxygen analyzer was observed to be monitored directly below the sensor mounted on a small pipe. The location of the attachments for the inlet and outlet could not be determined during the site visit. Readings ranging from 44% down to 7% were observed during the period of the site visit. It was stated[62] that the sensor is spanned with ambient air from 0 to 100%. The ambient air was used for the 100% value. No zeroing is performed on the unit. The oxygen concentrations registered by the meter ranged between 1.4 and 8.9% based on the stated calibration range. The average from charts[63] indicates a measured oxygen level averaging 4.83% oxygen in the fume exhaust stream to the TOU.

The venturi scrubbers remove some particulate material and condensable gases. These are the acids generated by oxidization in the TMW. Hydrochloric acid generation is tracked with a permit limit on the quantity of chlorine that may be placed into the unit[64]. Other halogen acids generated from Fluorine, Iodine and bromine are not tracked by the permit. Several tests[65] were performed on the vent line to demonstrate hydrochloric acid emissions rates. These tests did not accurately model the operation of the TMW. During the oxidization process, chlorine gas will be liberated and then combined with ionic hydrogen to form the hydrochloric acid. Therefore there is a potential for large quantities of chlorine to exist in the fume line. The venturi scrubbers will not remove chlorine gas from the fume stream. To structure a test using hydrochloric acid and then just vaporize the acid does not provide a reasonable representation of the halogen removal characteristics of the system. These halogens will form acids when heated in the TOU.

The acid removal in the scrubber will depend on the pH of the water. Rineco monitored the water twice a day[66]. Caustic was placed in the system when the pH was below the desired level[67].

TOU-102

The fumes exiting the venturi are directed to the afterburner designated as TOU-102[68]. The fume generator (TMW) and the TOU (afterburner) are typical of

[60] R035120, R035112,
[61] ERIN00031687
[62] Dr. Larry Williams comment
[63] ERIN00004648
[64] ERIN00000271
[65] ERIN00009288
[66] ERIN00031493
[67] ERIN00031739
[68] Id Footnote 10 Fig 038

hazardous waste kiln incinerators. The kiln (TMW) generates hazardous waste fumes and the afterburner (TOU) is positioned to accept the fumes and continue the destruction process of the hazardous waste fumes generated in the kiln (TMW). There is limited vent gas conditioning installed between the TMW and the TOU. The basic configuration TMW is not changed by the addition of this equipment, much as a boiler may be installed in a BIF unit.

The TOU is a typical ground flare[69]. The control is very simple[70] with only a damper opening[71] to add additional air when the temperature rises. Natural draft induces more air into the flare to continue the combustion process. If the change of the organic loading is too fast, the air will not be sufficient to meet the organic demand and fire will appear on the stack outlet[72].

Particles[73] from the 6 inch fume collection system[74] are fed into the TOU. The composition of these particles is and has not been monitored as it enters or leaves the TOU from the baghouse of the 6 inch line. Because the TOU is a simple ground flare, there are no air pollution control mechanisms for NOx, SOx, particulate or acids (generated from the halogen gas in the fume stream) that can be fit onto it. The temperature control is very simple without over-temperature control. In the event of high organic loading, there is no mechanism to limit the organic flow. The "40 foot" flames exiting the ground flare is a classic example of incomplete combustion within the TOU.

Conclusions

The operation of the TMW is predicated on the chemical reduction of the hazardous waste fed into the unit. The economic driver of the unit is to allow disposal of the hazardous waste in a cheaper manner. The feed stock is reduced through oxidization and pyrolysis into compounds that are blended into other hazardous waste streams that are burned for energy recovery in BIF units or burned in the TOU. Oxygen enters the TMW through seals and leaks when the TMW is under a negative pressure. Where the pressure can not be maintained at a negative level due to the material be fed into the unit, gaseous hazardous waste exits the unit.

The waste oil is a decomposition product of the hazardous waste feed. The char is a result of partial oxidization and pyrolysis reduction of the rags and other materials that did not fully degrade in the TMW. The metal content and

69 ERIN00006538
70 ERIN00034233
71 ID Footnote 70
72 ID Footnote 8 Page 41
73 ID Footnote 14
74 ERIN00016829

processing is a secondary function. Metal that could be processed in the BDU, is added to the TMW feed to increase the metal percentage loading for TMW reporting purposes only. Other streams (overs, pails, and diverts) are materials that would not decompose to a level that would allow their disposal in a cheaper method.

The TMW heats and treats hazardous waste. During thermal processing, the TMW converts most of the hazardous waste into new chemical compounds. These compounds exit the TMW at several exit streams. With the exception of the metal stream, most of the exit streams are blended into fuel and disposed of as a hazardous waste at a lower cost. The metal is sold but it constitutes such a very small percentage of the operational profit as to be considered minimal.

The TMW operation generates significant air emissions of a wide variety of hazardous wastes. Because there is a partial reduction (chemical change) in the chemicals fed into the TMW, the air emissions can not be fully defined. There are many chemical compounds that can be generated from the wide variety of hazardous wastes placed into the TMW. Therefore all fugitive emissions from the TMW must be viewed with extreme care due to their toxic nature.